

## WATER VAPOR TRANSMISSION RATE RESISTANT AND REPULPABLE CORRUGATED PAPERBOARD

### FIELD OF THE INVENTION

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The present invention relates to an improvement in corrugated paperboard, and more particularly, to a water vapor transmission rate resistant coated corrugated paperboard for packaging material, which is also repulpable.

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### BACKGROUND OF THE INVENTION

Corrugated paperboard is widely used in the packaging industry. However, the water absorption and moisture penetration characteristics of conventionally manufactured corrugated paperboard have made it unusable for containers for shipment of perishable foods. Thus, corrugated paperboard when used in making corrugated packaging is exposed to the ambient conditions and becomes the frontline for water vapor and humidity, which diminishes the performance of the paperboard container.

In an effort to overcome the susceptibility of corrugated paperboard container shipping boxes or containers formed of corrugated paperboard are usually coated with a water repellant material. The prior art discloses coatings that include natural and synthetic waxes and various synthetic organic compounds such as ethylene vinyl acetate. Such coatings improve the water resistance and decrease the water vapor transmission rate of the board so that the box is better suited for shipping perishables in a damp environment than an uncoated board. However, because most coatings materials cannot be dissolved in water or are water resistant, once used, such coated shipping boxes are difficult to recycle. Thus, conventional wax-based coatings cannot be separated to the degree necessary to enable satisfactory repulping of the board.

Examples of wax-free coating used in manufacture of corrugated paperboard are: U.S. Pat. No. 2,392,972 to Cheyney discloses surfacing of paper with a coating of vinylidene chloride-vinyl chloride copolymers; U.S. Pat. No. 3,476,587 to Demol et al. discloses compositions comprising two vinylidene chloride copolymers; U.S. Pat. No. 3,306,766 to Hathaway et al. discloses a paper based sheet, having the exposed surface thereof coated with a haloethylene polymer resin and an intermediate flexible foundation coating of extruded ethylene-lower alkyl acrylate copolymer resin; and U.S. Pat. No. 5,989,724 to Wittosch et al. discloses paper stock coated with polymeric dispersion, such as an acrylic polymers, acrylic copolymers, polyvinylacetate, polyvinyl chloride, and polyvinylidene chloride.

The references mentioned above disclose corrugated paperboard coated with wax or corrugated paperboard coated with wax-free coatings wherein the linerboard or the medium is coated on the outside, leaving the corrugated paperboard subject to the environmental decay. Thus, there is still a need for corrugated paperboard with comparable or better moisture barrier properties, which can better resist environmental decay while also having the added benefit of repulpability and recyclability.

## SUMMARY OF THE INVENTION

Having regard to the foregoing and other objects and advantages, the present invention is directed to a water vapor resistant paperboard that exhibits improved properties, and which paperboard is also repulpable. The paperboard sheet is especially well suited for use in the manufacture of corrugated boxes for shipping and storing food, particularly perishable foods that are affected by moisture-vapor. The invention is useful in food and industrial packaging containers that require a combination of high water vapor protection and repulpability.

Accordingly, it is an object of the present invention to provide coated paperboard wherein the corrugated medium is coated on the inner or outer

side or treated with a water vapor transmission rate resistant coating so as to achieve a water/humidity resistant boxboard that is repulpable.

Accordingly, it is an object of the present invention to provide coated  
5 paperboard wherein the corrugated medium is coated on the inner or outer side or impregnated with a water vapor transmission rate resistant coating and one or both linerboards is coated or treated with a water vapor transmission rate resistant coating so as to achieve a water/humidity resistant boxboard that is repulpable.

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It is an object of the present invention to provide coated paperboard wherein the one or both linerboards and/or the corrugated medium is coated or treated with a water vapor transmission rate resistant coating so as to achieve a water/humidity resistant boxboard that is repulpable, wherein the  
15 water vapor transmission rate resistant coating is polyvinylidene chloride, polyethylene terephthalate, acrylic, styrene butadiene rubber, and any mica formulation.

It is another object of the present invention to provide coated  
20 paperboard wherein the one or both linerboards and/or the corrugated medium is coated or treated with a water vapor transmission rate resistant coating that includes a hydrophobic material so as to achieve a water/humidity resistant boxboard that is repulpable.

It is an object of the present invention to provide coated paperboard wherein one or both linerboards and/or the corrugated medium is coated or treated with a primer, a water vapor transmission rate resistant coating then an adhesive coat, so as to achieve a water/humidity resistant boxboard that is repulpable.

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It is an object of the present invention to provide coated paperboard wherein one or both linerboards and/or the corrugated medium is coated or treated with a primer, a water vapor transmission rate resistant coating then

an adhesive coat which includes a hydrophobic material so as to achieve a water/humidity resistant boxboard that is repulpable.

5 It is an object of the present invention to provide coated paperboard wherein the one or both linerboards and/or the corrugated medium is coated or treated with a water vapor transmission rate resistant coating which includes a hydrophobic material so as to achieve a water/humidity resistant boxboard that is repulpable, wherein the hydrophobic material is aluminum, metals and ground hydrocarbon polymers.

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Another object of the present invention is to provide a water vapor transmission rate resistant coated paperboard of the character described that is economical to produce, to repulp.

15 A further object of the present invention is to provide a water vapor transmission rate resistant coated corrugated paperboard especially well suited for use in the construction of boxboards for shipment of perishable foods.

20 A further object of the present invention is to provide a method of producing the afore-mentioned repulpable corrugated paperboard.

In accordance with one aspect of the invention there is provided a repulpable corrugated paperboard comprising: (a) a first and second  
25 linerboard, each of said linerboard having opposed inner and outer surfaces, (b) a corrugated medium between the linerboards (c) said corrugated medium being adhesively secured to said inner surfaces of said linerboards; (d) at least one of said surfaces of said linerboard having a water vapor transmission rate resistant coating thereon.

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In accordance with one aspect of the invention there is provided a repulpable corrugated paperboard comprising: (a) a first and second linerboard, each of said linerboard having opposed inner and outer surfaces (b) a corrugated medium between the liners (c) said corrugated medium being

adhesively secured to said inner surfaces of the linerboards; (d) at least one of said surfaces of said linerboard having a water vapor transmission rate resistant coating thereon, and (e) said corrugated medium having a water vapor transmission rate resistant coating on at least one surface or  
5 impregnated thereon.

In accordance with one aspect of the invention there is provided a repulpable corrugated paperboard comprising: (a) a first and second linerboard, each of said linerboard having opposed inner and outer surfaces,  
10 (b) a corrugated medium between the linerboards; (c) said corrugated medium being adhesively secured to said inner surfaces of the linerboards; and (d) said corrugated medium having a water vapor transmission rate resistant coating on at least one surface or impregnated thereon.

15 In accordance with another aspect of the invention there is provided a method of manufacturing a repulpable corrugated paperboard wherein the paperboard components consists of one or more linerboard members and at least one corrugated medium, each of which is coated on both sides with a water vapor transmission rate resistant coating, said method comprising:

- 20 (a) applying a primer, a water vapor transmission rate coating and an adhesive to at least one side of the one of the linerboard members and/or the medium;
- (b) conducting the coated or uncoated medium to a corrugating section of a conventional corrugating machine; and
- 25 (c) adhering the corrugated medium to the linerboard by applying direct heating treatment to either or both of the linerboard or the corrugated medium at the bonding surface, so as to render the surface of one or both of the components tacky so as to allow bonding.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a fragmentary view, in cross section, of a sheet of corrugated paperboard.

## DETAILED DESCRIPTION OF THE INVENTION

5           Certain terms are employed herein to identify characteristics of the coating composition, the coated paperboard liner and the corrugated paperboard. These terms are believed to be clear in the context of the invention, to a person skilled in the art but are further elaborated here.

10           The terms "vapor resistant" refer to the tendency of the coating to repel, block or, in any event, not transmit or absorb any significant quantity of moisture or vapor in normal use. In other words, these terms identify a moisture/water-vapor blocking property of the coating sufficient for packing  
15           intended for perishable foods that are affected by moisture-vapor problems and protection from board degradation. The term "water vapor permeable" refers to the character of the coating in permitting passage therethrough of water in vapor form.

          The term "repulpable" refers to the character of the coated paperboard  
20           liner and the corrugated paperboard, whereby the paper fibre component of the paperboard liner and the corrugated paperboard can be readily recovered as a pulp suitable for use in paper product manufacture, the coating composition of the invention not presenting any significant obstacle to such pulp recovery. The term is to be viewed in the context that the conventional  
25           wax coated paperboard liners employed in corrugated paperboard packages for perishable frozen foods, are considered essentially non-repulpable based on a number of factors including the difficulty in separating the wax coated paper fibers and the contamination of any fibre pulp produced with wax particles which form stickies rendering the pulp unsuitable for paper  
30           manufacture.

          As such the term "repulpable" contemplates absence or substantial absence of wax or comparable materials that would render the paperboard liner and corrugated paperboard non-repulpable.

In the present invention the corrugated paperboard has the necessary characteristics for packaging of perishable foods, such as frozen foods, including water vapor repellency, and water vapor impermeability.

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#### Corrugated paperboard

Corrugated paperboard comprises an assembly of a pair of spaced apart linerboards with a corrugated medium sandwiched between and adhered thereto. The treatment of the corrugated medium and the employment and placement of the coating of the present invention on at least one side of the inner and/or outer surface of the first and/or second linerboards permits considerable variation in the manufacture of the corrugated paperboard, and results in a water vapor-resistant boxboard that is also repulpable and/or recyclable. Thus, the paperboard of the present invention has particular application in packaging such as for perishable frozen foods and bulk packaging in which the paperboard is required to be water vapor resistant and/or repellent.

The paperboard may be manufactured by any suitable papermaking process such as paper machine wet-end addition, size press addition, water base, steam shower calender stock, dryer cans. The corrugated paperboard may be assembled employing pre-coated paperboard liners which are water vapor resistant so that post-coating of the manufactured corrugated paperboard is not required, thereby considerably simplifying the manufacturing process of the corrugated paperboard. The linerboard and corrugated medium constructions is of single, double or any other multiple flute boxboards. The shape and dimensions of the container made in accordance with the present invention may be of any design. There is no basis weight restriction for the linerboards. That is, the linerboards may be of both the single facer and the double backer type.

#### Linerboards

The linerboard component used is of conventional linerboard material. In another preferred embodiment, the linerboards may be whitetop liner or

whitetop linerboard. The inner and/or outer surface of the first and/or second linerboard may be coated with the water vapor transmission rate resistant coating of the present invention using any suitable technique. Preferably, the coating composition of the present invention is applied on the felt or wire side of the linerboard at the wet-end of the paper machine. The coating may also be applied at an off site facility. Application of the coating to the linerboard may also be achieved by using a rod coating station (often noted as off-line coating) with multiple bumps (coated once, twice, three times, etc., two bumps being the most common) at a total coated weight of 0.25 to 8.0 lbs/msf (one thousand square feet). A rod coater is the most commonly used standard equipment. The material is dried after each bump (coating), and before any subsequent coating layer is applied. The coating may be extruded on one side or simultaneously on both sides of the linerboard in a single pass through an extruder, although two passes coating one side at a time could be used.

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#### Corrugated Medium

The medium component used is of conventional linerboard material, and comprises an outer and inner surface. The corrugated medium may be of 33, 45 lb/1000 ft<sup>2</sup> or other basis weight, and the corrugation may be B-, C-, E-, F- or any other available flutes. The corrugated medium is coated or impregnated with the water vapor transmission rate resistant coating of the present invention. Preferably, the coating composition of the present invention is applied on the felt or wire side of the medium at the wet-end of the paper machine. The coating agent may be applied using any suitable method, including but not limited to application on a paper machine at the size press. The coating may also be applied at an off site coating facility. A solution of the mentioned coating can be pumped directly to the size press and then applied onto paper by the size press or added and mixed in a size-press starch solution. The addition level of the coating agent may vary from 10 to 150 lbs/ton of paper to achieve various degree of water/humidity/vapor resistance. Internal sizing agents may be added directly into the papermaking furnish at the wet end of the paper machine. The coating may be extruded on one side or simultaneously on both sides of the medium (before corrugating)

in a single pass through an extruder, although two passes coating one side at a time could be used.

#### Coating Composition

5        The water vapor transmission rate resistant coating of the present invention includes but is not limited to polyvinyladine chloride, polyethylene teraphthalate, acrylic, styrene butadiene rubber, and any mica formulation. The coating composition may include hydrophobic materials including but not limited to aluminum, metals and ground hydrocarbon polymers. The coating  
10       composition may additionally comprise inert particulate filler and/or starches.

      The coating composition when applied to porous paper sheet material, such as linerboard and medium for use in corrugated paperboard manufacture, forms a water vapor transmission rate resistant coating, and the  
15       coated paper sheet material is pulpable, the coating separating readily from the paper sheet material during repulping.

      The coating is applied at the rate of from about 2 to about 5 pounds per 1,000 sq. ft. of board at a viscosity that will allow proper application, such that  
20       the coating will comprise from about 2 to about 5% of the total weight of the board, depending on the type of board. The coating composition may be applied using type of conventional coater, followed by forced hot air drying. The coated linerboard is converted to a double-faced corrugated board in a corrugator and the coated board is passed through the corrugator at a  
25       temperature required to provide proper bonding.

      The coating composition may be applied by a number of different methods. In addition they may be applied either on –corrugator or off-line. In on-line corrugator application the coatings can be applied on both the wet-  
30       and dry-end of the corrugator. This provides cost savings compared to an off-line coating application. In the wet-end application process, the dried coatings can be applied prior to the single facer and after the double facer. In the dry-end application process, coating can be applied after the hot plate section.

Various off-line coaters such as a rod coater, blade coater and air knife coater can be used to apply the coating. The coating is preferably dried thoroughly after the application in order to prevent any sticking or blocking within the coated rolls. Coated linerboard rolls are later run on a corrugated line to form the constructed board.

The coating on the linerboard may be applied to prior to assembly of the linerboard with the corrugating medium to form the corrugated paperboard, and this facilitates fabrication of the different components of the corrugated board at different sites by different specialists. The corrugated paperboard may be completed at the site of the board fabricator and the board fabricator does not need to apply coatings to the corrugated paperboard to provide the water vapor transmission rate resistance.

It has been observed that the boards coated according to the present invention exhibit improved water vapor transmission rate resistance and improved pulpability as compared with water-repellant boards such as wax-coated boards.

Figure 1 shows a cross-section of a portion of a corrugated paperboard 10 of the invention comprises a first linerboard 20 and a second linerboard 30 with corrugated medium 40 therebetween. The first linerboard 20 has an inner surface 22 adjacent to, facing and adhered to the first side of the corrugated medium and outer surface 21 opposite said inner surface. The second linerboard 30 has an inner surface 32 adjacent to, facing and adhered to the first side of the fluting and outer surface 31 opposite said inner surface.

The first linerboard 20 may be coated on the outer surface 21 and/or the inner surface 22; and the second linerboard 30 may be coated or laminated on the outer surface 31 and/or the inner surface 32. Thus, none or at least one of the outer surfaces or inner surfaces of the first or second linerboard may be coated. The corrugated medium 40 may be coated on either the outer surface 26 and/or the inner surface 28 with the coating of the present invention so that it is water/humidity resistant, and/or the coating may

be impregnated **30** in the corrugated medium. One or more layers of the coating of the present invention may be applied to any of the surfaces. The flute tips **44** of the corrugated medium **40** are adhered to the inner faces of linerboards **20** and **30** respectively.

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Thus, in an embodiment of the present invention, the first linerboard **20** is coated on the outer surface **21** and/or the inner surface **22**, the second linerboard **30** is uncoated, and the corrugated medium is untreated.

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In another embodiment of the present invention, the second linerboard **30** is coated on the outer surface **31** and/or the inner surface **32**, the first linerboard is uncoated, and the corrugated medium is untreated.

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In another embodiment of the present invention, the first linerboard **20** is coated on the outer surface **21** and/or the inner surface **22**, the second linerboard **30** is uncoated, and the corrugated medium is coated in the outer **41** and/or inner **42** surface.

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In another embodiment of the present invention, the second linerboard **30** is coated on the outer surface **31** and/or the inner surface **32**, the first linerboard is uncoated, and the corrugated medium is coated in the outer **41** and/or inner **42** surface.

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In another embodiment of the present invention, the first linerboard **20** is coated on the outer surface **21** and/or the inner surface **22**, the second linerboard **30** is uncoated, and the coating is impregnated **43** in the corrugated medium.

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In another embodiment of the present invention, the second linerboard **30** is coated on the outer surface **31** and/or the inner surface **32**, the first linerboard is uncoated, and the coating is impregnated **43** in the corrugated medium.

Thus, the corrugated medium is treated or impregnated with a water vapor transmission rate resistant coating. Preferably, the corrugated medium is first treated or impregnated with a primer coat, then a water vapor transmission rate resistant coating, then with an adhesive coat. In another embodiment one or more surface of one or both linerboard is treated or impregnated with a water vapor transmission rate resistant coating. Preferably, the linerboard is first treated or impregnated with a primer coat, then a water vapor transmission rate resistant coating, then with an adhesive coat on any surface. In another preferred embodiment the corrugated medium and one or more surface of one or both linerboard is treated or impregnated with a water vapor transmission rate resistant coating. Preferably, the corrugated medium and the linerboard is first treated or impregnated with a primer coat, then a water vapor transmission rate resistant coating, then with an adhesive coat on any surface. In another embodiment, the coating composition includes a hydrophobic material, and/or inert particulate filler and/or starches. The constructions used vary according to the goods being carried and the degree of water/humidity/vapor resistance they require.

It will be appreciated that the use of the corrugated board of the present invention in erecting boxes containing linerboards and corrugated medium coated in accordance with the invention improves the repulpability of the box so that containers made from such board may be more readily and more economically recycled than boxes made of conventionally wax coated water vapor transmission rate resistant coated paperboard, and provides a recycled pulp of improved quality.

It has also been observed that a board coated according to the present invention exhibits improved repulpability as compared with wax-coated boards and boards coated with polyethylene resin or extrudable film-forming thermoplastic resins such as polypropylene, as well as polyolefin coatings.

Additionally, board produced in accordance with the present invention exhibits improved resistance to blocking under warm and humid conditions.

This generally improves the handling properties of the board in relation to stacking of flattened-out boards or blanks and conveyance of the board through the stages of manufacture, and limits blocking of adjacent boxes in shipment and storage.

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The present invention provides advantages over prior practice in providing a paperboard, which can be recycled by conventional methods without any special measures or equipment.

10 It will be recognized by those skilled in the art that the paperboard of the invention have wide application in the production of packages or containers having water vapor resistance and moisture vapor barrier characteristics.

15 The foregoing description of various and preferred embodiments of the present invention has been provided for purposes of illustration only, and it is understood that numerous modifications, variations and alterations may be made without departing from the scope and spirit of the invention as set forth in the following claims.

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